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SCIENCE

NEW YORK, DECEMBER 8, 1893.

SOME GEOLOGICAL FEATURES OF JACKSON PARK, CHICAGO.

BY D. E. WILLARD, UNIVERSITY OF CHICAGO, CHICAGO, ILL.

VISITORS to the great Columbian Exposition during the past season can hardly have failed to have been impressed with the beauty and harmony of the landscape features of Jackson Park. Those who have made topography a study must have found it a place of especial interest.

Only when one compares the Jackson Park of 1893 with that of former years can he realize the greatness of the transformation, or comprehend the herculean task which confronted the gardener in his attempt to bring beauty and harmony out of this wild, and from an artistic standpoint, chaotic region, or appreciate the magnificent success with which the problem was finally solved and the wild waste transformed into a place fit to be called the "Garden of the Gods."

The Jackson Park of former years, in large part a wild and unimproved morass, a succession of sandy ridges and low stretches of marsh, the resting place of water-loving fowl during their season, and the resort of game-loving marksmen, contrasted with that of 1893, with its beautiful avenues, glittering lagoons and studded islands, a dreamland of beauty in its rare combination of nature and art, surely presented a marvellous example of what it is possible for the landscape gardener to accomplish.

To understand the matter at all well, the topography of the adjacent vicinity must be studied, which at once introduces us to a very interesting geological problem.

Along the borderland of Lake Michigan in the vicinity of Jackson Park may be observed ridges running southward and diverging from the lake shore, varying in width from a few yards to a considerable fraction of a mile, and in height from that which barely distinguishes ridge from adjacent lowland to twenty feet or more; the front edge, *i. e.*, the eastern or one toward the lake, usually being more or less abrupt, while that on the opposite side not infrequently grades down to the adjacent marsh so evenly as to make it difficult to determine where the ridge ends and the marsh begins.

If the observer traverses the lake shore southward he finds these ridges occurring at irregular intervals, and if he follow one of them along its course he will soon find himself at considerable distance from the lake, and ridges rising to view both to the eastward and westward.

Examination of their structure where exposed in cellars or excavations for sewers, or perchance where a sand-pit has been opened, reveals stratification and evidence of distribution and deposition in water, with alternating layers of coarse and fine sand and gravel.

The intervals between the ridges are marsh or lowland, and during certain seasons of the year are often covered with water.

The ridges are easily recognized from a distance by the oaks which usually—and, so far as our observations have extended, always—cover them in a state of nature, a sharp tree-line marking the transition from ridge to marsh.

If from the roof of the Manufactures Building or other elevated standpoint the region south of the park be surveyed, one observes that a broad level plain stretches southward from the boundary of the park (Sixty-seventh street), toward South Chicago, Pullman, and Lake Calumet, the eye being able to trace the landscape clearly as far as about One Hundredth street. This region is seen to be traversed in a generally north-south direction by lines of trees, which, by closer observation, are found to coincide with the sand ridges.

Abutting against the southeast corner of the park there is observed a grove of oaks of considerable extent consisting of broader or narrower tree-covered belts (ridges), separated by narrow strips of lowland (lagoons), while toward the lake other tree-belts are noticed, separated by low even tracts of marsh-land of varying width, entirely destitute of trees. And again, for some miles to the westward lines and patches of trees indicate ridges or outliers, and a nearer approach reveals some very high and extensive ones.

If the grove mentioned above be examined more closely, it will be found to consist of a somewhat complicated series of ridges and lagoons.

Near Seventieth street, the first ridge in the series which we can study satisfactorily—some having been destroyed by grading—to the east from Stony Island avenue (which forms the western boundary of Jackson Park) divides to the southward, and the intervening lagoon[1] gradually widens. The ridge is quite pronounced, especially as to its front, along east of the tracks leading to the Terminal Station, and here again the second lagoon, which forms the interval between the first and second ridges north of Seventieth street, becomes narrower and presumably disappeared a short distance further north in the park. This second ridge is quite regular in outline, and transversely symmetrical. It has to a striking degree the appearance of an old-fashioned country "turnpike" road before it has been distorted by heavy wagons. It is as evenly built as a gardener could have made it with his shovel and rake, rising gradually and evenly to a height of about four and a half feet, and then as evenly, though slightly more abruptly, descending to the lowland on the east or lakeward side. It is about eight rods in width at Sixty-ninth street, two blocks south of the park fence, and is separated from the next ridge by a lowland belt at this point, about four rods in width, which, however, gradually widens southward, and narrows northward till it disappears, and the two ridges unite just south of the park limits. The highest point of the combined ridge, just above the juncture of the two adjacent edges, is about six feet.

Eastward again of this third ridge or eastern arm of the second (which is about twenty-five rods in width) extends a broad level tract of lowland of a breadth of a hundred rods, covered with a growth of rushes and other marsh plants, and so low that it is covered with water during the wet seasons of the year and furnishes a favorable haunt for wild fowl and a tempting field to the sportsman. Still further east is a broad ridge sagging

[1] The terms lagoon, lowland, and marsh-belt are used interchangeably throughout this discussion, for the low interval which separates the ridges, whether or not it be covered all or any part of the year with water.

sharply along its dorsal line to a depth of half its total height; followed by another belt of lowland eight or ten rods in width; and lastly a peculiarly irregular, low, broad ridge, which quickly terminates southward, and is bordered on the east by the present lake beach.

It seems probable from a study of this region and comparison with the park to the north, that the Administration Building stands on a continuation of one or more of the ridges just described, while the broad, low belt mentioned above has its continuance embracing that part of the park on which were located the dairy and stock barns, the Stock Pavilion, the Agricultural Building, the Court of Honor or Grand Basin, and part of Manufactures Building, together with the area covered by the South Pond. Presumably the ridge on which stands the Administration Building is one which extends northward, forming part of the Wooded Island, and, as the native oaks give evidence, extends past the site of the Turkish, osta Rica and other foreign buildings, continuing along the east end of the north lagoon and Art Annex to the northeast corner of the park.

The presence of the large native oaks on a part of the Wooded Island shows the former existence of the dry, sandy soil of a ridge, while the absence of the trees in other parts becomes negative evidence that it is filled or artificial land, as the mud which was scooped out from the low places, forming the artistic lagoons, was piled along the margins to fill sinuses and level depressions.

The presence of a few large trees near the Government Building bespeaks a ridge, and the grading of the grounds indicates traces of the same, despite the gardener's skill. But whether here was a distinct ridge on which stands part of the Manufactures and the Government Buildings, and running over toward Victoria House, or whether it was only an outlier, or whether it was a ridge at all, is involved in uncertainty.

From the Convent La Rabida a ridge seems to take its origin, on which stands also the Krupp Gun Works, part of Shoe and Leather, thence extending southward along the east margin of South Pond and west of Anthropological Building, and continuing, as the ridge described as lying east of the wide belt of lowland south of the park. The ridge mentioned as adjacent to the present lake beach and very irregular in its outline and disappearing suddenly southward, just enters the park touching the Forestry Building.

Another distinct ridge crosses the northwest corner of the grounds, on which stands the California State Building, Washington, South Dakota, the Esquimaux Village and others. This soon disappears from the grounds to the westward, the oaks in Buffalo Bill's enclosure indicating its location upon the ridge. The lagoon or pond which extends into the Esquimaux Village is probably a natural sag or lagoon scooped out deeper, but it is impossible to determine, since the grading outside the park fence has destroyed all traces.

From these observations it is seen that the lagoons of Jackson Park—those objects of so much delight and pleasure to World's Fair visitors, those gem stones of earth in a silver setting of water, which completed the indispensible features of the perfect landscape and gave the finishing touch of beauty to this fairy dreamland of nature and art—are the excavated marsh-belts which formed the lowlands between the oak-covered ridges above described, the deep muddy, marshy or water-covered places being made deeper and the excavated material being used to fill sinuses and depressions,—in fact, that these lagoons were a necessity in the reduction of a dismal desert waste to a perfect landscape garden; were formed because nothing else could be done with the water; in short, the process was but one of giving back to the sea her own, the lowland belt becoming what it originally was before being filled by the processes of time—a lagoon.

We have not space to discuss the geological history of this region, but may say in closing that Lake Michigan has, at a not early time, geologically occupied many square miles of territory now embraced in part in the city of Chicago and vicinity—that a great region about the head of the lake is entitled to the Indians' appellation of "Chica-gow" or "Skunks' Nest," and that these ridges are beach-ridges successively piled up by the waves of the receding lake, and the marsh-belts are the filled and filling lagoons which are formed in such shore processes.

NOTES AND NEWS.

Two numbers of a new university publication upon geology have lately come to notice, reminding one in their form and general aspect of the bulletins of the Geological Society of America. The new publication is the Bulletin of the Department of Geology of the University of California. It is edited by Prof. Andrew C. Lawson. In the two parts of the first volume there are seventy-two pages and five plates. The articles are "The Geology of Carmelo Bay," by A. C. Lawson and J. de la C. Posada, and "The Soda-Rhyolite north of Berkeley," by Charles Palache. The new enterprise has a wide field open to it. Comparatively speaking, very little work has been done upon the geology of California, and the problems are numerous and important. Aside from the two quarto volumes upon the Geology of California, the work of the U. S. Geological Survey and the few early government expeditions, little has been done in the State. Many of the problems are so intricate that it is not to be expected that they will be solved in the short time given to them by government expeditions. The great extent of the State, and the vast variety of soils and geological formations found in it, will form fertile themes for discussion and investigation for many years to come. It is the intention of the university to issue the parts at intervals as material accumulates, and when a volume of 350 or 400 pages has been printed the subscription price of $3.50 will be requested. Subscriptions can be sent to Prof. A. C. Lawson, University of California, Berkeley, California.

—G. P. Putnam's Sons will publish immediately the first volume of "Social England: a record of the progress of the people in religion, laws, learning, arts, science, literature, industry, commerce and manners, from the earliest times to the present date," edited by H. D. Traill, D. C. L. The work is to be completed in about six volumes, and the one about to be published presents the record from the earliest times to the accession of Edward I. They also announce Le Gallienne's "Religion of a Literary Man," "Wah-Kee-Nah, and Her People," a study of the customs, traditions and legends of the North American Indians, by James C. Strong, late Brevet Brigadier-General Reserve Corps, U. S. A.

—J. B. Lippincott Co. announce another of Robert S. Ball's popular books on astronomy, entitled "In the High Heavens," to be profusely illustrated by drawings in the text and full-page colored plates.

—The large and curious philological library of the late Prince Lucien Bonaparte is soon to come into the market. It numbers about 25,000 volumes. The Prince early determined to make a collection of works which would represent not only every written language in the world, but their connection one with another, and also their dialectal varieties; and he was able to a large extent to carry out this idea. His collection includes a specimen of every English dialect. His usual plan was to get the Gospel of St. Matthew or the Song of Solomon translated into the different dialects by experts.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

THE ATMOSPHERES OF THE MOON, PLANETS AND SUN.

BY G. H. BRYAN, M. A., CAMBRIDGE, ENGLAND.

IT was only a week or two before reading Professor Liveing's interesting communication in *Science* that I had made some calculations which led me to adopt the same theory which he has advocated. The object of my investigations was, in fact, to show that we could not regard the atmospheres of the different members of the solar system as isolated masses of gas, from which molecules might fly off if their speeds were to become sufficiently great, but that, to account for the very existence of planetary atmospheres at all, it would be necessary to adopt the hypothesis of an atmosphere of excessive tenuity pervading both interplanetary and interstellar space.

It is unfortunate that Mr. Howard did not apply the principle of conservation of energy to the arguments contained in his letter in the issue of April 28. Had he done so he would have realized that the question as to whether a molecule will permanently leave the atmosphere of the Moon or a planet depends only on its speed, irrespective of direction, and does not in any way depend on whether the motion takes place in a vertical direction. In fact, if the kinetic energy of a molecule is greater than the work required to be done against the planet's attraction in order to remove the molecule to an infinite distance, the molecule will describe a hyperbola, and will fly off never to return again, no matter what be its direction of motion, provided that it does not come into collision with any other molecule or with the planet itself.

Again, the speed required to leave the Earth is about five times as great as that required to leave the Moon; but this is not because the earth's attraction is five times as great as the Moon's, but because the Earth's *potential* is about twenty-five times as great as the Moon's, consequently, in order to leave the Earth, a particle would require to have twenty-five times the kinetic energy, or five times the speed, which it would require to leave the Moon.

According to the well-known "error law" of distribution of speed among the molecules of a gas, which forms the basis of calculations connected with the kinetic theory, there must always be *some* molecules moving with sufficiently great speeds to overcome the attraction of any body, however powerful, and *some* whose speed is too small to enable them to escape from the attraction of any body, however feeb e. On this assumption no planet can have an absolutely permanent atmosphere, and no planet or satellite which has ever had an atmosphere could get rid of that atmosphere entirely. If, however, the proportion of molecules which escape is relatively exceedingly small, any changes which occur in the nature of the atmosphere of the planet will take place so slowly that countless ages will have to elapse before they make themselves felt. In order, therefore, to test the relative degree of permanence of the atmospheres of different celestial bodies, I have calculated what proportion of the molecules of oxygen and hydrogen at different temperatures have a sufficiently great speed to fly off from the surfaces of, and never return to, the Moon, Mars and the Earth. I have also given the corresponding results for the Sun, not, however, at its surface, but at the Earth's distance from the Sun's centre, where the critical speed is, of course, square root of two times the speed of the Earth's orbital motion.

The numbers, which are given in Table 1 below, represent in each case the average number of molecules, among which there is *one* molecule whose speed exceeds the critical amount. Thus, for oxygen at temperature 0°C, rather over one molecule in every *three billion* is moving fast enough to fly off permanently from the Moon, and only one in every 2.3×10^{139} is moving fast enough to escape from the Earth's atmosphere, while the Sun's attraction, even at the distance of the Earth, prevents more than one in every 2×10^{4946} from escaping.

When we arrive at such vast numbers as this, it might be reasonable to object that we have pushed the kinetic theory a great deal further than it will go. The assumptions made in many proofs of the "error" law of distribution certainly preclude its application to high speeds that are so rarely attained. Still there is no physical limit to the speed which any individual molecule might acquire in the course of colliding with other molecules. As Professor Liveing has pointed out, all that would be necessary would be a sufficiently long run of collisions, in each of which the line of impact happened to be nearly perpendicular to the direction in which the molecule in question was previously moving, so that each impinging molecule should transfer the greater portion of its energy to that one molecule.

And theory points to the conclusion that whenever there is any law of permanent distribution of the molecules of a gas, that law must be the "error" law. Hence the calculations may be reasonably expected to give a correct estimate of the proportion of molecules whose speed exceeds the critical speed, provided that the mass of gas under consideration is so large that the *total* number of such molecules is great, however small their relative proportion may be. Thus we are at least justified in regarding the figures as affording indications of the relative permanency or otherwise of the gaseous envelopes surrounding different bodies of the solar system.

One great difficulty presented by the theory is that oe taking account of the differences of temperature of the atmospheres of the different bodies. There seems to be good reason for believing that the Moon's temperaturf may fall below —200°C., in which case only one molecule in 7×10^{51} will be able to escape. And generally the larger members of the solar system are the hotter, and this would cause them to part with their atmospheres more readily in proportion than they would if all the bodies were at one common temperature. If the absolute temperatures of different bodies were proportional to their gravitation potentials, the proportion of molecules possessing the speed requisite to carry them off would be the same for all. This condition would require the Earth's atmosphere to have an absolute temperature roughly twenty-five times as high as that of the Moon's. Even supposing this were the case, it does not necessarily

follow that the Moon's atmosphere would be of as permanent a nature as the Earth's, for the gain and loss of molecules would only take place near the upper limits of the atmospheres, where collisions rarely occur; hence the question of permanency would largely depend upon the extent of the atmospheres surrounding the two bodies.

The figures tend to show that the Earth would lose its atmosphere very slowly, even if plunged in vacuo, and that the Sun's atmosphere may be regarded as *practically* permanent, even independently of the hypothesis of an interstellar atmosphere. But the impossibility of assuming losses to be taking place from the atmospheres of planets without a compensating accession of molecules from the surrounding space is at once evident when we endeavor to trace the past history of the solar system.

If the Moon ever had an atmosphere which has now flown off into space, losses of a similar nature must necessarily have taken place in the atmospheres of all the planets at a time when they were much hotter than they are at present, especially in the case of so small a planet as Mars. And if we trace the history of the solar system further and further back, we find that, if the planets were hotter and hotter, they must therefore have been parting with their gaseous envelopes at a greater and greater rate,—a condition of things which would render it impossible to account for the initial existence of planetary atmospheres.

The nebular hypothesis supposes the Sun and planets to have been evolved by the gradual contraction and condensation of a nebulous mass of gas. This process would be exactly the reverse of the flying-off process suggested by a perusal of Dr. Robert Ball's paper.

It is only necessary to assume the existence of a distribution of matter of excessive tenuity pervading interplanetary space, in order to account for the permanence of the planetary atmospheres at all temperatures; and such an assumption, taken in conjunction with the kinetic theory, is *quite compatible* with the absence of any *perceptible* atmosphere surrounding the Moon.

The kinetic theory enables us to compare the densities at different points of a mass of gas in equilibrium under fixed central forces, such as the attractions of the celestial bodies. If we apply the theory to the system consisting of the Sun, Moon and Earth, we shall find the relative densities given in Table 2, the density of the corresponding gas in the atmosphere at the Earth's surface being taken as unity. If we take the density at an infinite distance from the Sun to be unity, the corresponding results will be given by Table 3.

The assumption on which these results are calculated may be called an "equilibrium theory," since it takes no account of the motions of the bodies in question, and it assumes a permanent distribution to have been attained, so that the whole of the mass is at a uniform temperature.

When every allowance is made for the artificial character of the assumptions, it is still highly unreasonable to suppose that the Moon could have an atmosphere so far in excess of that required by the equilibrium theory that its presence could be detected even by the most careful observations.

And so far from its being necessary to assume the density of the interplanetary atmosphere to be a millionth of a millionth of the density at the Earth's surface, we should, on the assumption of a uniform temperature of 0°C, have to divide the latter density by a million over and over again fifty-five times, before we had reached the degree of tenuity required by the equilibrium theory for the interplanetary atmosphere in the neighborhood of the Earth's orbit. Taking the number of molecules in one cubic centimetre of air as a million million million and employing the figures calculated for oxygen, we should have to construct a cube, each of whose sides was 10^{100} kilometres long, in order to enclose a hundred molecules of a gas of this degree of tenuity. Thus, if we multiply a million by a million and repeat the process sixteen times and then multiply by ten thousand, and take this number of kilometres as the side of a cube and place one hundred molecules of gas inside it and the Earth in the middle, that hundred molecules would be sufficient to make up for any loss that is going on at the surface of the Earth's atmosphere. It is similarly evident from the figures in Table 1 that countless ages must elapse before a single molecule leaves the Earth's atmosphere, and that no perceptible equalization is taking place between the atmospheres of different planets.

If we try to compare the atmospheres of different planets, such as the Earth and Mars, the "equilibrium theory" breaks down completely. But it would be highly unreasonable to suppose that anything like a *permanent* law of distribution existed between two bodies at such vast distances apart, separated by a medium of such extreme tenuity, and subject to solar radiation and so many other disturbing causes. The molecules of gas flying about in interplanetary space are so few and far between that collisions can only rarely take place between them, whereas any tendency of approach towards a permanent state of distribution must necessarily depend on frequency of collisions between the molecules. Hence the rate of equalization of energy among the molecules of so diffuse a medium must be infinitesimally slow, so slow indeed that practically no such equalization is taking place at all. It is different in the case of two bodies so near one another as the Earth and Moon. Among the molecules of gas which at any time might find themselves in the neighborhood of the Moon and Earth, the greater number would be drawn in by the more attractive body, and the moon would not, therefore, be likely to obtain more than her fair share of air, which, as we have seen, is very small in comparison with that allotted by the equilibrium theory to the Earth.

Table 3 affords some idea of how the density of the Earth's atmosphere would increase with the gradual cooling of the solar system. According to this theory, a similar increase has been taking place in what little atmosphere there is surrounding the Moon, and at no period of its history has it possessed an atmosphere of oxygen and nitrogen comparable in density with that of the Earth. A decrease of density in a planet's atmosphere could only take place by the condensation in liquid form of vapors present in it, not by matter leaving the planet.

The figures given in Table 3 are more than sufficient to account for the comparative rarity of hydrogen in the Earth's atmosphere, but a similar argument would also, of course, require a considerable preponderance of oxygen over nitrogen, which is contrary to experience. But here again we have pushed the equilibrium theory too far. It is highly probable that the number of molecules flying about both in interplanetary and interstellar space is far greater than that given by the accompanying tables, and the inference is that the atmospheres of the planets are increasing in density at a rate far greater than that due to cooling alone. Even so, however, the few molecules picked up by the Earth in the course of a year or even a million years may have no *appreciable* effect on the density or composition of the atmosphere. Hence, while, as Professor Liveing asserts, the same chemical elements may be expected to enter into the constitution of all the celestial bodies, there appears to be no warranty for supposing them to be in any way regularly distributed as regards their relative proportions; and on the other hand

there is every reason for believing that the existing law of distribution may differ vastly from the law of permanent distribution required by the kinetic theory of gases.

TABLE 1.

Average number of molecules of gas to every one whose speed is sufficiently great to overcome the attraction of the corresponding body:

	Hydrogen at 0°C (—273° absolute) Oxygen at 4095°C (—4368° absolute.)	Hydrogen at —205°C (—68° absolute.) Oxygen at 819°C (—1092° absolute.)	Hydrogen at —246° (—17° absolute.) Oxygen at 0°C (—273° absolute.)	Hydrogen at —269°C (—4¼° absolute.) Oxygen at —205°C (—68° absolute.)
Moon's surface	3.6	610.0	2.7×10^{12}	6.9×10^{51}
Surface of Mars	3920.	5.0×10^{13}	1.0×10^{64}	1.8×10^{268}
Earth's surface	6.0×10^{19}	3.3×10^{81}	2.3×10^{330}	4.5×10^{1332}
Earth's atmosphere at a height of 80 miles	2.3×10^{19}	7.6×10^{79}	5.7×10^{322}	1.5×10^{1296}
Sun at same distance as Earth	2.7×10^{387}	6.6×10^{1238}	2.0×10^{4949}	1.7×10^{19767}

TABLE 2.

Relative densities of oxygen and hydrogen in a permanent distribution taking their densities at the Earth's surface as unity:

	H at 0°C (273° abs) O at 4095°C (4368 abs)	H at —205°C (68° abs.) O at 819°C (1092 abs.)	H at —246°C (17° abs.) O at 0°C (273° abs.)	H at —269° C(4¼° abs.) O at —205°C (68° abs.)
Earth's surface	1	1	1	1
Earth's atmosphere at a height of 80 miles	.3899	.02268	2.414×10^{-7}	3.4×10^{-27}
Moon's surface	3.1×10^{-20}	9.4×10^{-79}	37.7×10^{-319}	3.5×10^{-1249}
At Moon's distance from Earth	4.6×10^{-21}	4.6×10^{-82}	4.5×10^{-326}	4.0×10^{-1302}
At Earth's distance from Sun	2.1×10^{-21}	1.9×10^{-82}	1.4×10^{-331}	3.6×10^{-1324}
Interstellar space	2.7×10^{-330}	4.9×10^{-1316}	5.6×10^{-5724}	9.9×10^{-21694}

TABLE 3.

Relative densities in a permanent distribution, taking the average densit of distribution of the gas in interstellar space as unity:

	H at 273° absolute O at 4368° abs.	H at 68° abs. O at 1092 abs.	H at 17° abs. O at 273 abs.	H at 4¼° abs. O at 68° abs.
At Infinity	1.0	1.0	1.0	1.0
At Earth's distance from Sun	7.9×10^{308}	3.9×10^{1236}	2.4×10^{4942}	3.6×10^{19769}
At Moon's distance from Earth	1.7×10^{309}	9.4×10^{1236}	8.0×10^{4947}	4.0×10^{19791}
At Moon's surface	1.2×10^{310}	1.9×10^{1246}	1.4×10^{4961}	4.2×10^{19844}
At Earth's surface	3.7×10^{329}	2.0×10^{1317}	1.8×10^{5723}	1.0×10^{21693}

ON THE LIFE ZONES OF THE ORGAN MOUNTAINS AND ADJACENT REGION IN SOUTHERN NEW MEXICO, WITH NOTES ON THE FAUNA OF THE RANGE.[1]

BY C. H. TYLER TOWNSEND.

THE range known as the Organ Mountains, in southern New Mexico, was determined by the U. S. Geodetic Survey, if I mistake not, to rise to a height of 8,800 feet above sea-level. This altitude has been carefully veried by observations taken by Professor C. T. Hagerty, of the Civil Engineering Department of the New Mexico Agricultural College. The western base of the range is about twelve miles to the eastward of Las Cruces, in Doña Ana County. The range runs nearly north and south for a distance of about twenty miles. It varies in width from about four to eight miles, the north extremity as well as the south one being much narrower. It is intersected a little south of the middle by a wide and detoured pass known as Soledad Cañon. The San Augustine pass divides the range near its north end. About two miles to the north of this pass begin, by common consent, the San Andres Mountains, a lower range which extends on to the northward for about fifty miles. About three miles south of San Augustine pass is a rather high and more difficult drop in the range, known as Bayler pass. The highest peaks of the Organs are north of the centre of the range, and their upper portions are mostly bare and nearly inaccessible. There is a ridge between the southernmost two peaks and those peaks to the north of them. This ridge is probably 8,000 feet or more in elevation, and its highest portion is the point to which the zones given below have been traced. It dips about 200 feet at its northern end.

The altitude at the western base of the range is about 4,800 feet, or 1,000 feet higher than the site of Las Cruces, situated twelve to fifteen miles west on the edge of the Rio Grande Valley. Thus the above mentioned ridge is, roughly speaking, about 4,000 feet above the surrounding country, or about 3,000 feet above the base of the range.

The various points above mentioned will be better understood by consulting the accompanying diagram of the range. It is only a diagram, no attempt having been made to secure accuracy of detail.

It may be stated that, to the northeast of the range, stretch away the plains of San Augustine; while to the northwest is the vast waterless expanse known as the Jornada del Muerto, or Journey of the Dead, where seventy miles has to be covered between springs. To the eastward of the range is a vast level sandy plain which extends some eighty miles to the Sacramento Mountains, and plains stretch away likewise to the southeast, and for a less distance to the south. For some of the beauties of the Organ Mountains, I would refer the reader to a paper by Mr. Charles H. Ames, in *Appalachia* for 1892. The point reached by Mr. Ames was the lowest part of the ridge above referred to between the peaks, being the dip at its northern end.

Beginning at the east bank of the Rio Grande River, in the bottom of the valley, and going eastward until the highest portion of this ridge between the peaks is reached, the following zones, in the order given below, are encountered. The actual ascent to this ridge, during which most of the data of the higher zones were carefully noted, was made on Nov. 12, 1892. We left the house at Riley's ranch at 9.00 A. M., and reached the highest part of the ridge at about 12.15 P. M., thus making fully 3,000 feet in three and one-quarter hours. Starting back at 12.30 P. M., we reached the house again at 2.55 P. M. It should be stated that there was much snow in the dense brush through which we passed in the higher portions of the range, and that on many occasions we had to proceed in a reclining attitude over long stretches of smooth rock at an angle of about 35°. The house at Riley's ranch is 4,900 feet altitude, and the ridge, as above mentioned, about 8,000 feet.

Tornillo or Cottonwood Zone.

About 3,300 to 3,800 feet.

Characteristic plants.—Prosopis pubescens (tornillo), Populus fremontii var. wislizeni (valley cottonwood), Salix spp. including S. longifolia (willows), Aster spinosus (spring aster), Helianthus annuus (common sunflower), Helianthus ciliaris (dwarf sunflower), Xanthium sp. (cocklebur), Rhus sp. (sumach), Sphæralcea angustifolia, Solidago sp. (golden rod), Baccharis angustifolia (at its climax), mistletoe, grasses, etc.

[1] Read before the New Mexico Society for the Advancement of Science, at Las Cruces, April 6, 1893.

Mesquite Zone.

About 3,800 to 4,800 feet.

Characteristic plants.—Yucca baccata (Spanish bayonet—at its climax), Yucca angustifolia (narrow-leafed yucca), Prosopis juliflora (mesquite), Larrea mexicana (creosote bush), Opuntia lepticaulis (vine cactus), Opuntia arborescens—some (tree cactus), Ephedra nevadense (clapweed), Opuntia spp. (smaller-leafed prickly pears), Opuntia engelmanni—some (prickly pear), Echinocactus wislizeni (barrel cactus), Cereus spp. (bunch cacti), Atriflex canescens (sage bush), Fallugia paradoxa—some along arroyos, Fouquiera splendens (candle wood), Krameria parvifolia, Zizyphus lycioides, Baccharis angustifolia, Parkinsonia sp. (?), Acacia sp. (cat's-claw thorn), Chilopsis saligna (along arroyos, and especially near base of mountains), Perezia nana, certain grasses on plains to north (Jornada del Muerto), etc.

Dasylirion or Scrub Oak Zone.

About 4,800 to 6,800 feet.

Characteristic plants.—Dasylirion wheeleri (sotol), Quercus undulata var. wrightii (scrub oak), Opuntia arborescens (tree cactus—at its climax), Yucca baccata (Spanish bayonet), Accacia sp. (cat's-claw thorn), Opuntia engelmanni (prickly pear or tuna—at its climax), Agave heteracantha (century plant), Agave parryi (Parry's century plant), Unguadia speciosa (Mexican buckeye), Celtis occidentalis (hackberry), Fraxinus sp. (ash), Robinia neomexicana (New Mexico locust), Fallugia paradoxa, etc.

Juniper or Cedar Zone.

About 6,800 to 7,500 feet.

Characteristic plants.—Juniperus sp. (cedar), Cercocarpus parvifolius (mountain mahogany), Garrya wrightii, etc.

Pine Zone.

About 7,500 to 8,800 feet.

Characteristic plants.—Pinus edulis probably (piñon), Pseudotsuga douglassii (Douglas spruce), Quercus undulata var. gambellii (a scrub oak on top of ridge, 8,000 feet), Pinus ponderosa (Californian pine), etc.

The above are the more important forms of vegetation met with in going up past the Modoc mine to the top of the ridge (slope with western exposure); in going up a long side cañon which opens into Soledad on the north at a point about a mile east of Mr. Isaac's place (mostly south exposure); and also as noticed in general in the whole range, on the western slopes, from Soledad to the south end. As before said, the zones were more particularly noted in the ascent to the ridge above the Modoc mine, Nov. 12, 1892, as this is about the highest accessible point in the range.

On Nov. 26, 1892, an ascent was made to the top of the ridge of the northeast portion of the range. The results of this trip are detailed separately below. Going up this slope, which has a north-northeast exposure, the following seventeen characteristic species of vegetation were noticed. The real ascent was begun at a point about four or five miles a little east of south of San Augustine. Exactly a year before this, I made an ascent nearly to the top of the higher portion of the same ridge about two miles farther to the westward, on which many of the same plants were also noted.

Plants found on going up northeast slope of Organ Mountains, Nov 26, 1892.—The vertical distance was divided into approximate fifths, which are spoken of as first to fifth belts. This vertical distance from the level

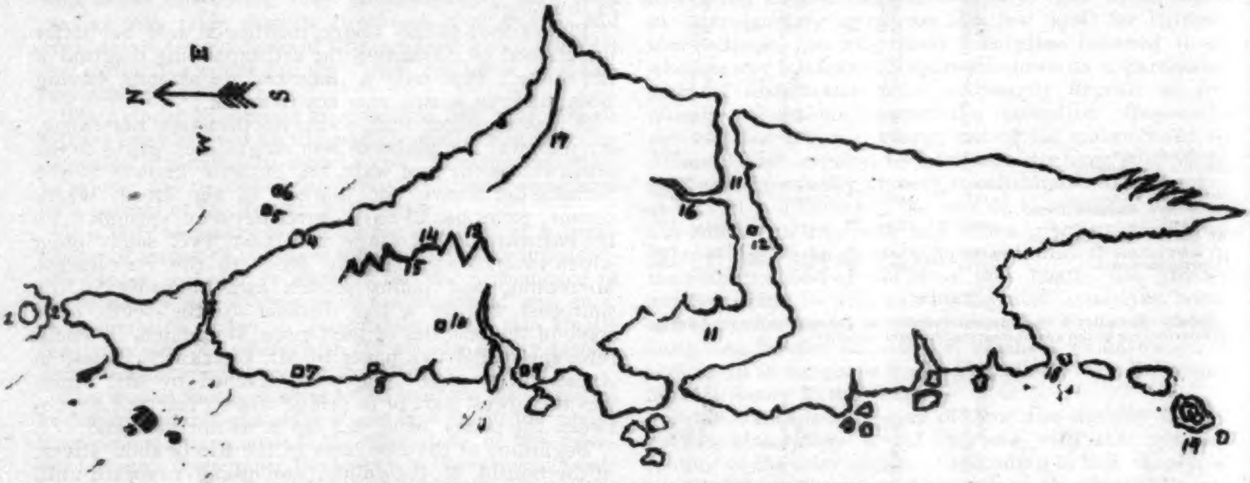

DIAGRAM OF THE ORGAN MOUNTAINS IN SOUTHERN NEW MEXICO.

1. Organ peak.
2. Organ pass.
3. Bayler pass.
3. Sugar loaf.
5. Old San Augustine hotel.
6. Davies-Lecinsky ranch.
7. Stephenson-Bennett mine.
8. Riley's well.
9. Riley's ranch.
10. Modoc mine.
11. Soledad canon.
12. Isaac's ranch.
13. Highest peaks (8,800 ft.).
14. Highest part of ridge betw. peaks.
15. Dip of ridge at north end.
16. Side canon opening into Soledad.
17. Ridge of northeast part of range.
18. South and wagon pass.
19. Bishop's Cap.

at San Augustine to the top of the ridge is probably about 2,000 feet, the ridge being, apparently, about 7,000 feet elevation at its eastern end. The lower range of the hardier species, as shown below, is due to the north or northeast exposure.

1. Cat's-claw thorn (Acacia sp.).—Extending from near base of mesa-like prolongation of north end of range through first belt.

2. Mulberry (Morus parvifolia).—Upper portion of cat's-claw thorn area or first belt.

3. Mexican buckeye (Unguadia speciosa).—Second belt.

4. Wild grape (Vitis sp.).—Second belt.
5. Wild cherry (Cerasus sp.?).—Second belt.
6. Maple (Acer sp.).—Second belt.
7. Small bunch cacti (Cereus 2 spp.).—Third belt.
8. Ash (Fraxinus pistacifolia).—Third belt.
9. Hackberry (Celtis occidentalis).—Third belt.
10. Willow (Salix sp.).—Third belt.
11. Cottonwood (Populus sp. much resembling P. fremontii).—Third belt.
12. Scrub oak (Quercus undulata var. wrightii).—Third and fourth belts. Often hung with mistletoe.
13. Piñon (Pinus edulis?).—Large trees on lower ex-

tent of fourth belt. (Perhaps P. ponderosa as well).

14. Jimson weed (Stramonium sp.)—Fourth belt.

15. Mountain mahogany (Cercocarpus parvifolius).—Fourth and fifth belts.

16. Oak (Quercus undulata var. gambellii).—Fifth belt, below but near top of ridge.

17. Thornless chaparral (Fallugia paradoxa).—At top of ridge, fifth belt, forming a thick chaparral on north slope.

It should be mentioned, as a possible explanation of the higher altitude at which the scrub oak, hackberry, etc., were found on this slope than on the western slope, that in the ascent the course of a stream was followed about to the third belt.

Notes on the fauna of the Organ Mountains.—Mammalian fauna: The range contains a wide and varied extent of country, particularly between its northern widened portion and Soledad cañon. Of the larger mammals, there were formerly, as reported by hunters, elk, mountain goat, mountain sheep, and bear. These are not known to exist there at present, but Mr. G. R. Beasley, of Soledad cañon, is reported to have killed a full-grown male mountain sheep two years ago in the Organs. There are said to be some bears at the present time in the more inaccessible portions of the range, but this is not positively known.

There are known to exist at the present time: Deer (probably the black-tailed, Cariacus macrotis); mountain lion (Felis concolor); wild cats (Lynx sp.); red and silver foxes (Vulpes spp.); skunks (Mephitis sp.); squirrels (Sciurus sp.); chipmunks (Tamias gracilis and other spp.); weasels (Putorius sp.); civet cats (Bassaris sp.); and raccoons (Procyon sp.). Bats and mice also occur. Antelope, rabbits, badgers, prairie dogs, coyotes, are found at the base or in the lower portions.

Avian fauna: Californian quail, tonto quail (Ortyx spp.), eagles, hawks, buzzards, owls, jays, woodpeckers, doves, mocking birds, orioles, whippoorwills, wrens, swallows, humming birds, and others have been noted in the range. Unfortunately specimens were not collected, so that no specific determinations can be given. Wild turkey are said to occur, but I have seen none. They were common in the range formerly.

Reptilian fauna: Rattlesnakes (Crotalus sp.), several species of harmless snakes, and several species of small lizards have been observed. The rattlers are more frequent on the plains at the base of the range. Frogs are also said to occur.

Fish fauna: There are no fishes that I know of, as the mountain streams are small and swift, and often dry, for a long season. In the Sacramento and White Mountains, about sixty to eighty miles north and northeast, there is fine trout fishing in the streams.

Insect fauna: Many species of insects abound, a large number being peculiar to the range in this region, i. e., not found on the mesa and in the valley to the westward. These, in most cases, feed on such plants and trees as are likewise peculiar to the range. The following are those species which feed on some of the principal plants, so far as I have observed them, arranged under the heads of the plants:

Sotol (Dasylirion wheeleri).

1. Thrincopyge alacris—larvæ bore flower stalks.
2. Hesperobænus n. sp.—adults eat newly forming flowers.
3. Thrincopyge ambiens—larvæ bore flower stalks.
4. Acmæodera culta—larvæ bore in flower stalks.
5. Moth—larvæ bore flower stalks.
6. Lecanodiaspis yuccæ—scale on leaves. Also on Yucca baccata.
7. Small weevil—bores in flower stalks.

Scrub oak (Quercus undulata var. wrightii.)

1. Andricus sp.?—makes a woolly, reddish gall on leaves.
2. Another gall-fly—makes a fleshy leaf gall.
3. Synergus sp. and Decatoma sp.—the first makes a large apple-like and very hard woody gall on twigs, in which the second is apparently an inquiline.
4. Geometrid moth—larva feeds on foliage.
5. Several species of Lepidoptera—larvæ feed on foliage.

Hackberry (Celtis occidentalis).

1. Pachypsylla venusta—forms a leaf-stalk or petiole gall.
2. Pachypsylla celtidis-pubescens—forms a small circular gall on leaves.
3. Cecidomyiid—makes small round gall on leaf-stems.

Many carnivorous bugs and beetles abound in the range. Butterflies are more numerous than in the valley. There are bees, wasps and ants; dragon flies, many locusts, larvæ of gnats in the streams, including buffalo gnats (Simulium occidentale); and flies of many families, especially those of parasitic and creophilous or coprophagous habits. A single specimen of a peculiar large blister beetle (Megetra vittata) has been found in the mountains and nowhere else in this immediate region, but many were found higher up in western New Mexico. Tarantulas (Lycosa sp.), centipedes (Scolopendra), viñagrones or whip-scorpions (Thelyphonus), and true scorpions also occur.

Molluscan fauna: Quite a number of specimens of a snail have been found in several parts of the mountains about half way up the range. Prof. T. D. A. Cockerell, to whom I gave some of the shells for determination, writes me that they are undoubtedly a variety of Patula strigosa Gould.

In conclusion, it should be stated that the determinations of the plants mentioned in this paper were made largely by the Botanical Division of the U. S. Dept. of Agriculture, and by Mr. Walter H. Evans, now of that Department also. A few were made by Prof. E. O. Wooton, botanist of the N. Mex. Agr. College.

POTTERY ON PUGET SOUND.

BY JAMES WICKERSHAM, TACOMA, WASHINGTON.

THAT the reader may not be misled by the above headline, I hasten to say that there never was any aboriginal pottery made either on the Columbia River, Puget Sound or in the regions northward to Alaska. Baskets of such strength, firmness and texture were made, however, that the absence of pottery was not a hardship upon the Indians, for they carried water in baskets, and even boiled food in them by the use of hot rocks constantly dropped in the water. But what lesson, if any, can the ethnologist learn from the absence of pottery on this northwest coast?

Let us first look at the character of the civilization existing here prior to the advent of the white man and compare it with that of other localities—say San Francisco Bay, but a few hundred miles farther south on the same shore. The Indians of Oregon, Washington, British Columbia and Alaska made and constantly used the finest canoes in the world, capable of holding fifty or sixty men. They fearlessly pursued the whale on the Pacific Ocean, far out of sight of land; and fastening their harpoons to the monster by the use of inflated bladders, they caused him to float; and after his death he was towed by a line of great canoes to the shore; where, landing the huge carcass,

his captors feasted in truly Indian style. But a few hundred miles away the Indians of San Francisco Bay rode on a raft or bundle of reeds! The conclusion follows irresistibly that a different aboriginal civilization existed from the Columbia River northward to Alaska than that on San Francisco Bay. From a careful examination of the archæological remains it seems quite certain that the lines connecting the middle type of civilization of the Puget Sound region with other American civilizations lay—one up the Columbia and across to the Ohio region, and the other by way of the Snake River, Great Salt Lake and the Pueblo region, and connecting with the Mexican country. But in each of these regions —in Ohio and Mexico—we find pottery in abundance, but none in the Puget Sound basin. This cannot be on account of lack of material, for the finest potters' clay exists in great beds throughout this region on the surface, and many potteries now work it. What is the conclusion, then? It is that the high civilization of the Northwest coast did not come either from the east or south!

This middle type of civilization on Puget Sound made splendidly carved war canoes; the finest basket work in America; featherwork like the Aztecs; metalics like those of Moqui; wove blankets equal to the Navajo; worshipped the sun like the Mexican, and made stone gods equal in carving to those of Central America; as carvers of wood they have no equals in America; they were artisans skilled in carving, weaving and painting; they built permanent homes of great posts and cedar boards, exactly like the Mongolian tribes of Asia—exactly like the Japanese; their beds were arranged on each side of the houses on platforms in the true Mongolian style; their language yet preserves the identical tongue spoken by the Apache and other southern Athapascan; many pure Aztec words linger north of Puget Sound—and yet they made no pottery!

No nation ever lost the art of pottery-making. The art never was known to the people of this northwest country; though they are cousins to the Algonquins and Aztecs and brothers to the Apaches, yet they had not the art possessed by these people of making vessels from clay. Not a trace of the potter's work can be found in the Columbia River or Puget Sound regions. Although these people are of kin, yet in this particular they are as distant as the poles. It follows that the Athapascans of Mexico learned the potter's trade after they left the early home of their kinsmen on Puget Sound; it also follows that the Apache and kindred tribes were migrants from the north, and it is true that the Algonquin was not a potter until after he reached the Mississippi valley.

It seems to me that one certain result follows from the known facts, viz.: That the Athapascan tribes of Mexico, and possibly the Aztecs, migrated to Mexico from the Puget Sound region—for if our Athapascans came to the north from Mexico and settled in the Puget Sound basin, why did they not bring that most characteristic manufacture, pottery, with them? I take it that the conclusion must be conceded that the migration was southward, and not by San Francisco Bay, either, but via Great Salt Lake to Mexico.

Humboldt, Prescott and other eminent authorities place Aztlan, the ancient Aztec hiving place, in the Puget Sound region, and certainly the absence of pottery here is a strong additional fact in support of their statements. If, now, it be conceded that the hiving place of the Aztecs, Apaches and other southern Athapascans was on Puget Sound, may it not also be granted that this is some further proof of the Asiatic origin of the same tribes?

DISPOSAL OF WASTE AT THE WORLD'S COLUMBIAN EXPOSITION.*

BY W. F. MORSE, NEW YORK.

When it was seen that the proposed World's Fair would occupy 600 acres of ground, have a resident population of thirty to forty thousand, and an average of one to three hundred thousand daily visitors, it was apparent that the sanitation of the grounds was a problem of some magnitude, and one that must be solved without the chance for an error, as after the opening there was no time for changes of plans.

For the drainage the Shone Hydro-Pneumatic System was chosen. This is an English apparatus, which receives, in tanks under the floors of the buildings, all the sewage from toilet rooms, and by compressed air automatically employed forces it into large tanks or reservoirs at one central station. The sewage is then precipitated by chemicals, the effluent run off into the lake, and the residuum pumped into presses which deliver it in solid cakes for disposal.

Besides this sewage sludge, the waste food products from restaurants and the refuse and litter of all sorts taken together would amount to a vast bulk of waste to be destroyed. There was no convenient place outside the grounds where this might be dumped, the lake was impracticable for the purpose; it must be burned, and this must be done on the grounds of the Exposition.

The Engle Sanitary Garbage Cremator was selected as the one which promised best results, and two large furnaces were built in the fall of '92. At the opening of the Fair the work of disposal of all garbage, sewage sludge, waste, refuse, manure and the bodies of animals was begun and has been carried on without cessation for six months. The results of this work give a better idea of the value of garbage cremation than any reports yet published.

The two furnaces used crude petroleum oil as fuel, atomized this by air, obtained the power from an electric motor, and with a pressure of twelve ounces of air and using six to seven gallons of oil per hour for each burner, obtained as high a degree of heat and did the same work which would be done by a steam burner using 120 lbs. pressure of steam and a much larger amount of fuel.

The sewage cake contained fifty-eight per cent of liquid, and of the remainder only eighteen per cent was combustible. The garbage contained water in large amounts, rising sometimes from sixty to eighty per cent. Because of the necessity of being always open for inspection, more men were employed than would usually be needed, thus adding extra expense.

There was at no time any discharge of odors, fumes or smoke from the chimney; the results of combustion (carbonic acid gas) were colorless and invisible, and being discharged fifty feet from the ground at a temperature of 1,000° were quickly dissipated.

The cost of labor and fuel was from sixty to seventy cents per ton, the sludge costing considerably more than the garbage. At other places where furnaces of this same type are employed, this cost has been brought down to eight to twelve cents per cubic yard, equivalent to twenty to thirty cents per ton.

The bodies of animals—four horses, two camels, cows, deer, elk, pigs, dogs, etc., were destroyed with ease and speed.

The Engle furnaces are constructed with two fires, the first or primary fire burning the garbage and waste by direct application of flame, the smoke, gases and fumes from this combustion being driven forward into a second

*Extract from paper read at World's Public Health Congress, Chicago, Oct. 10-14, 1893.

fire at the other end of the furnace. Combustion is assisted by hot air inlets and by combustion chambers, thus making it possible to consume the most offensive matter, to destroy or convert into gas the product of this combustion, and to do this with speed and economy at places near to houses and in the presence of large numbers of people. The garbage and sewage sludge resulting from the presence of twenty-seven and one-quarter million of persons has been destroyed in six months to the entire satisfaction of the Exposition authorities and under the observation and in the presence of thousands of persons. The furnace received the highest awards in medals.

BIRD NOTES.

BY MORRIS GIBBS, KALAMAZOO, MICH.

Rapacious birds and beasts retain their love of destroying, even after years of confinement, and it is a well-acknowledged fact that among those rapacious animals of a menagerie which are reared in confinement, we find the most ferocious and destructive examples, if they once escape and become aware of their power. As a fitting illustration of this principle of general acceptance, the following instance is offered:

A friend of mine took two half-grown young from a nest of the great horned owl, *Bubo virginianus* (Gmel.), five years ago last spring. These birds were always kept in confinement and were never in the presence of other birds or mammals which might have formed their food in the wild state.

Within a few months past the pair escaped from their pen, and instead of flying to the woods, they immediately sought out a hen-house at a neighbor's less than sixty rods distant, entered it and mangled and killed over a dozen chickens. The owner of the hennery appeared on the scene and caught the owls red-handed in the midst of the carnage.

This is certainly a much more destructive onslaught than is recorded from the visitations of wild owls in my experience.

In watching the gulls which follow the steamers on the sea or great lakes, the question has often occurred to me, Do these same birds follow the boat day after day, or do the birds of the day drop out and others take their place? I have repeatedly noticed individuals leave one steamer and follow another, oftentimes in a different course and sometimes directly opposite to the formerly selected route. Of course during the nesting season gulls or other birds cannot fly to any great distance, but in the summer, fall and winter months they certainly can and do follow ships for immense distances.

On a trip in a coasting steamer from New York to Jacksonville a few winters ago, I had a favorable opportunity to prove that a gull could follow a vessel for a great distance. Soon after passing Hatteras we noticed one of the gulls in the good-sized flock which followed the boat, to have an injured leg. The foot hung so that the passengers could readily identify the cripple.

When we reached Charleston harbor the crippled gull was still picking up scraps thrown overboard from the galley, but was soon lost to us in the fog which surrounded us for hours while we waited to cross the bar. The next morning, when the passengers went on deck, there was our gull which had met the vessel on coming from the harbor, whether by accident or design I cannot say. The cripple followed us up the St. Johns River, and was often remarked upon by the passengers who had come to know it. This bird, which was one of the larger gulls, but I cannot be positive in regard to the species, followed our steamer fully five hundred miles.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

A Mistake in Teaching Botany.

Allowing for some measure of truth in the article under the above heading in your issue for Oct. 20, I still think that the writer is in error in several of his recommendations and in some of his criticisms.

Probably the system of teaching botany at present in vogue in many schools and colleges is far from perfect, but I very much doubt if the introduction of the changes proposed would effect any improvement. Some of them would, I am persuaded, be injurious.

The writer condemns the old plan of a spring term in botany spent on the study of the phanerogams and followed by the analysis of fifty to one hundred plants, and he suggests if no more time can be given to the study that the teacher should tell the names of the plants and save the time for more important work, adding that, as for analysis, experience shows that a large part of the work, when not done under the supervision of the teacher, is accomplished by ascertaining the common name and then going to the index. He afterwards suggests that those who have been confining the study to the phænogams should give half of the time to the cryptogams, and even adds that every one who studies botany at all should learn something about bacteria, smuts, moulds, mildews, etc., and that vegetable physiology should form an important part of the work of the first term.

I cannot infer with certainty from the article if the writer is a teacher or not, but after many years' experience in the work it appears to me that any attempt to cover the ground proposed must end in failure so far as real scientific education is concerned.

Consider for a moment the mental position of a class of beginners of any age and in any science, botany for example, utterly ignorant of scientific method and unversed in scientific work, and too often, if beyond childhood, mentally purblind from the pernicious habits of thought and work engendered by the book-instruction of which school work mainly consists. For such scholars the whole available time of a term is required to learn how to work, and the difficulty of studying even a phænogam is quite sufficient to engross their attention without entering on the intricate ground of cryptogamic botany. The organs of a plant, their parts, their names and functions, their description and the nomenclature, with other important but untechnical topics that can be incidentally introduced by the teacher, such as the elements of geographical distribution, economic botany, forestry, etc., are more than enough to fill the time while the scholar is wrestling with the elementary difficulties of the science. And the teacher of experience knows that a considerable time is necessary for the assimilation of even this minimum of knowledge, and that it is impossible to reduce this amount if any real mental discipline is desired, because the organic law of mind demands repetition, variation and attention before facts and their significance and words and their ideas can make a permanent impression on the memory and the intellect. Any other course can end only in a smattering, and in the past this method of procedure has too often brought so-called scientific teaching into disrepute.

Moreover any one accustomed to working in the higher departments knows how little can be accomplished in the

hundred and twenty hours or thereabouts that form the available allowance in a single term, even after the attainment of a fair knowledge of phænogamic botany. To acquire the necessary skill in the use of the compound microscope will alone consume no small part of the time, and without this nothing of value can be done among the cryptogams.

Again, to tell a class the name of a plant instead of teaching them how to discover it for themselves is to rob the study of much of its special value in training the faculties of observation. This part of the work compels a close and repeated examination of the plant and renders the parts and their names thoroughly familiar as no other method can do it. And speaking from a long experience, I cannot believe that the art can be acquired by less practice than that afforded by the analysis of the fifty or more specimens usually required, unless, as is sometimes, and as should be always done, the description of the plants is made a part of the work. And this description should consist not merely of the filling up of the forms usually supplied, whereby the exercise is robbed of much of its value, but by requiring the whole from the scholar, thereby training him in recollecting what to look for without suggestions or leading questions. No practice in elementary botany is so useful as this.

Of course a part of every class, especially if it is large, will shirk the labor when they are out of the class-room. But shirking in the way suggested can easily be prevented by giving a plant which has no English name and in general by testing a scholar's progress by the work done in the class-room from day to day.

I need not do more than allude to the difficulty, I may say the impossibility, of supplying elementary classes with microscopes of sufficient power for the purpose advocated in the paper here referred to, without which the study must degenerate into a mere absorption of what the teacher tells. This would be little more than a waste of time and a degradation of science to the level of a mere memory study.

On yet one other point I must disagree with this author. There was, some years ago, a disposition to begin the study of a science at the bottom and work upward, and this in spite of strong remonstrances from many teachers of great ability and experience. Even a man like Huxley fell into this error, as may be seen in the early editions of his "Biology." But a few years' test showed the many disadvantages of this method, and the opposite, or older plan has been readopted. Whatever may be urged from the standpoint of theory, practice is unanimous on the other side. Steady advance from the known to the unknown is easier than a plunge into the mysteries of cryptogamic botany with its abstruse terminology and its minute, often almost invisible structure. For every one who might be attracted by the delicacy and difficulty of the subject a thousand would be disgusted and disheartened and would forsake the study forever.

The author's illustration from geology is unfortunate because in teaching this subject the best plan is to begin neither with the superficial nor the deep rocks. This savors of book geology. The proper plan is to begin with whatever rocks happen to lie within the range of the student's investigation. Here again we work from the known to the unknown.

The object of the teacher in every study should be to stimulate to farther advance, and this cannot, I think, be accomplished except by beginning with the easy and the obvious, and by assigning tasks well within the strength of the student. If a fair acquaintance with the structure of the phænogams and the methods of phænogamic botany can be attained in the first term devoted to the study, the time will have been well spent, and neither the teacher nor the average scholar can reasonably expect much more. E. W. Claypole.

Akron, Ohio.

Coral Reef Formation.

In *Science* for Oct. 20, p. 214, I observe that Professor Perkins gives a succinct account of the history of the theories of coral reef formation. Darwin and Dana have, of course, their proper place in connection with the "*subsidence theory.*" Agassiz is justly mentioned as declaring that there was no subsidence in the case of the Florida reefs. Guppy and Semper are very properly mentioned along with Murray in connection with the new views; but my name is not mentioned in that connection. Let me, then, quote from a paper of mine read before the A. A. A. S., Aug., 1856, and published in the Proceedings and also in the *Am Jour.*, Jan., 1857: "On sloping shores with mud bottom, such as we have supposed always existed at the point of Florida, a fringing reef cannot possibly be formed, for the water is rendered turbid by the chafing of waves on the mud bottom; but at some distance (in this case ten to twenty miles), where the depth of sixty to seventy feet is attained, and where the bottom is unaffected by waves, the conditions favorable for coral growth would be found. Here, therefore, would be formed a *barrier reef*, limited on one side by the muddiness and on the other by the depth of the water."

This is positively the first attempt to explain barrier reefs without resorting to subsidence. Captain Guppy worked out the same explanation independently long afterward, but on becoming acquainted with my paper promptly acknowledged the anticipation of his views. I quote from a communication by him to *Nature* (Vol. 35, p. 77, 1886): "When I arrived at the above conclusions I was not aware that substantially the same explanation had been advanced thirty years before by Prof. Joseph Le Conte in the instance of the reefs of Florida. * * * * The circumstance that barrier reefs are frequently situated at or near the border of submarine plateaus receives a ready explanation in the view *first advanced* by Professor Le Conte."

When I wrote my paper I did not dream of generalizing my conclusions or of invalidating Darwin's theory except as applied to Florida. The subsidence theory was to me then, as it is now, the most probable general theory for the Pacific reefs. I am little disposed to make reclamations. Except on the score of history, it matters little who first brings forward an idea. My paper is now thirty-seven years old. In the midst of all these discussions of new views I have been silent. My paper, therefore, has almost dropped out of the memory of the younger generation of naturalists. This is my only excuse for bringing it up now. Joseph Le Conte.

Berkeley, Cal., Nov. 10.

BOOK-REVIEWS.

Tables for the Determination of the Rock-forming Minerals. By F. Loewinson-Lessing. Translated by J. W. Gregory. New York and London, Macmillan & Co. 55p., 8vo., $1.25.

The literature of micropetrology has of late received an interesting addition in the shape of a translation by J. W. Gregory of F. Loewinson-Lessing's tables for the determination of rock-forming minerals. Unlike the *Hülfstabellen zur Mikroskopischen Mineralbestimmung* of Rosenbusch, or the *Tableaux des Mineraux des Roches* of Michel, Levy and Lacroix, the work is something more than a bare list of the rock-forming minerals with their optical properties, but has for its avowed purpose an attempt to apply to micropetrology the system "so long applied in

botany for the rapid determination of plants by using one character after another." In carrying out the scheme six tables are given, of which the first is synoptic, while the second deals with the methods of determination of minerals by the aid of polarized light; in the third the morphological character of the minerals is made the distinguishing characteristic, and in the fourth the determination of the crystalline system. In table five the minerals are classified upon crystallographic grounds, and in table six the positive or negative character furnishes the desired clue to identification. To the original work (published in Russian) the translators have added a brief chapter describing a petrographical microscope and its accessories. The work is not intended to be exhaustive, but rather as introductory to the larger works of Rosenbusch and others. To students beginning the study, and particularly to those working without instruction, the book cannot fail to be of great service.

The Mummy; Chapters on Egyptian Funereal Archæology. By E. A. WALLIS BUDGE, L.D., F. S. A. Cambridge, University Press. 404p., with 88 illustrations, 1893, $3.25.

IN his preface the author justly observes: "The preservation of the embalmed body or mummy was the chief end and aim of every Egyptian who wished for everlasting life." Hence, a large proportion of the monuments and remains of ancient Egypt are of a sepulchral character, and an intimate acquaintance with what relates to their mortuary beliefs and ceremonies well nigh exhausts Egyptian archæology.

Impressed with this fact. Dr. Budge has chosen "the mummy" as the one object of study, but this in the widest relations. He begins his volume with a brief sketch of the history of the lower Nile valley, furnishes a list of the dynasties, the cartouches of the principal kings, and a list of the nomes or provinces. Next, beginning with the Rosetta stone as a text, he describes succinctly the discovery of the methods of reading the hieroglyphic writing. This brings him to his immediate subject, the mummy, its preparation and surroundings. Short but satisfactory descriptions are given of such appurtenances as mummy cloth, Canopic jars, the Book of the Dead, *ushabti* figures, sepulchral boxes, vases, toilet articles, scarabs, amulets, figures of the gods and sacred animals, sarcophagi and tombs. Mummies of animals, reptiles, birds and fishes receive some attention, and there are instructive paragraphs on Egyptian writing and writing materials, and the Egyptian numbers and months. The book closes with lists of the more common hieroglyphic characters and determinatives. The whole is presented with great clearness, and with a full, accurate and scientific knowledge of the subject. As a practical handbook to Egyptian archæology, it has no superior, within the lines the author has laid down for himself.

The Outdoor World. By W. FURNEAUX, F. R. G. S. New York, Longmans, Green & Co. 411 p.

Our Household Insects. By EDWARD A. BUTLER, B. A., B.Sc. New York, Longmans, Green & Co. 342 p.

The Industries of Animals. By FREDERIC HOUSSA . Imported by Charles Scribner's Sons. 258 p., $1.25.

A History of Crustacea. By REV. THOMA R. R. STEBBING, M. A. New York, D. Appleton & Co. (International Scientific Series, Volume 71). 466 p., $2.00.

DURING the last few years the laboratory naturalist has very largely taken the place of the old student in natural history, and work on biological subjects in general is to-day quite largely carried on in the laboratory by means of the microscope and the dissecting knife. The reason for this can be largely traced to our modern education, which, in trying to introduce biological subjects into educational curricula, must do it in such a way that the student can carry on his work in different branches at the same time. This is hardly compatible with a very widely extended field work. As the result of this laboratory method, laboratory text books and laboratory technic have become well developed and well known, and readily meet the student's requirements. The general public, however, will always be more interested in the side of natural history that treats with animals and plants in a general way, and books to be widely instructive must contain facts never to be learned in the laboratory. Even the laboratory naturalist himself finds relief and pleasure in leaving his scalpel and microscope and turning through the pages of some well written book upon the study of nature on a broader scale. The four zoölogical books above listed represent a better class of the popular scientific books which attempt to deal with phases of nature in a wider way and in a more popular style.

The first of the four is a book designed for boys and young people in general, and has for its purpose the attracting young students to the study of nature. This book attempts to give descriptions and figures of such common animals and plants as a wide awake boy might be able to obtain by ordinary collecting methods. Methods of collection are given, simple and readily obtained forms of apparatus for collection are described, and directions are given the reader as to where and how he may most likely find certain animals and plants. In the different chapters of the book different groups of animals and plants are taken up for discussion and description. The book abounds in figures describing the organisms mentioned, as well as the apparatus used and methods of preservation. The scope of the book covers all types of animals which the boy may be supposed to find, from the smallest (not including microscopic animals) to the largest, and from coelenterates to man. It comprises the study of fresh water, land and marine animals, and is arranged in such a way as to give the boy an interest and a zest in his study of nature in whatsoever line he chooses, and withal a deal of scientific information is given. The book is, in short, just the sort of text book that a boy wants to interest him in natural history, and the figures, many of which are colored, are such as both to attract and instruct.

The second of the four is of quite a different character and is designed as an introduction to entomology. It gives an anatomical and a general account of such common insects as one may find in and around his home. The anatomical description is illustrated by figures and is more or less detailed. Bits of history of different species of insects are introduced, many accounts of interesting habits are described. As the insects are taken up one after another, the author brings up for discussion just the sort of questions which the semi-scientific reader will desire to ask and have answered. He discusses such matters as the poison of mosquitoes; the origin and habits of flies; the distribution and origin of cockroaches; methods of getting rid of many of the insect pests, etc. Quite a number of excellent figures are given illustrating the anatomy, and a few excellent photographic plates of some of the smaller insects are introduced. This book, in short, gives the sort of an account of common insects as the elementary student in entomology may desire to have.

Both of these books being English books, the species described and figured are English species. They are for this reason less valuable to an American student, but at the same time the difference in species between English and American is not so great that the books are not usable here.

The third book is even more entertaining to the gen-

eral reader, treating as it does of the habits of insects and giving little or nothing in regard to the dry details of anatomy. The author attempts here particularly to describe the industrial habits of animals, more particularly those of social animals. He describes the methods of hunting and the methods of carrying of war and the general methods of defence of animals. He gives an account of the various habits possessed by animals of obtaining and storing provisions, describing the habits of gardening ants and agricultural ants, and giving an account of the slavery that exists among certain species of ants as well as their habits of "cattle keeping." He gives an account of the methods for rearing the young; of the methods of building houses and of the material and architecture of the dwellings of various animals; discusses habits of sanitation and defence against diseases. This account is extremely entertaining reading and is full of the most striking incidents. The preacher will find anecdotes for illustration; the lecturer find examples to enliven his lectures; the psychologist will find many facts to ponder over and explain, and every one will find much to interest and to wonder about, so that, on the whole, a more readable book on entomology can hardly be mentioned.

The last of the four has quite a different scope and is of a more technical scientific character. The fact that this is one of the International Scientific Series is enough to determine its high character. The author aims to give in this book a complete account of the higher crustacea (Malacostraca). He was unfortunately, however, obliged to leave out the description of the Amphipoda, since the space assigned to him would not admit of their treatment. This book begins with a careful description of the general anatomy of the crustacean groups, with an outline of their classification. This part of the book is, unfortunately, not illustrated by figures, so that it will be hardly intelligible to one not acquainted with the material beforehand. Then there follows, in separate chapters, descriptions of the various orders, tribes and families of the crustacea and a short account of all of the important genera. Numerous illustrations of more common species are given throughout the book, and the descriptions and history of the different genera will prove of especial value. This volume of the International Scientific Series is an especially valuable book for a student wanting a thorough knowledge of crustacea, for it will enable him to determine the general character and relations of any crustacea which he may find, and in many cases enable him to determine any species at hand, although it does not pretend to be a systematic account of the crustacea. Even a more valuable book will it be for a reference library book. Unlike the other three books above given, this one can hardly be regarded as a readable book, but must be looked on as a work for reference. As such a book it will find a valuable place in the libraries of all students of zoölogy.

Elementary Palaeontology for Geological Students. By Henry Woods, B. A., F. G. S. Cambridge, University Press. 222 p., $1.60.

This little book is a text-book, designed for the student to use with specimens of fossils in his hands. It gives the general characteristics of the groups of animals important to the palæontologist and a brief description of the most important genera of fossils. It gives also at the close of the discussion of each group an outline history of the group in the past. The book is of value as a guide to a student who has access to a good collection of fossils; but having almost no figures of fossils in it, it is of no use for any other purposes. It is not designed, indeed, for any other purpose, but the geological student will find it a convenient handbook to carry into a museum for reference and study.

—Messrs. Macmillan & Co., of New York, announce for January, 1894, in their "Book Reviews": "The Study of the Biology of Ferns by the Collodion Method; for Advanced and Collegiate Students." By Geo. F. Atkinson, Ph. B., Associate Professor of Cryptogamic Botany, Cornell University. Profusely illustrated. The book is designed for laboratory instruction and for reference on the development and structure of ferns. It consists of

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two parts—Part I. is descriptive and deals in full with the life-history of ferns; Part II. deals with methods of study. The descriptive portion of the work is arranged in seven chapters, six chapters being devoted to the Leptosporangiate homosporous Filicineæ, and one chapter to the Ophioglosseæ. The chapters on the ferns trace in detail the development, morphology and anatomy of the gametophytic and sporophytic phases. The text is in no sense a compilation, but is written after a thoroughgoing and serious investigation by the author, using the Collodion Method as a means of bringing the material under contribution, so that in a very large measure it is written from nature revealed by original preparations. One unique feature of the work is the result of a critical examination by the author of the structure of the sporangium in the different orders of ferns and the dispersion of the spores. In the light of this study it is clearly shown that the customary statements regarding the extent of the annulus must be modified. The 163 illustrations are all original from camera lucida sketches, accompanied by a magnified micrometer scale, so that the reader can at once compute the magnification. All of the illustrations of sections are from objects prepared by the Collodion Method, and several of them from preparations made by students of the author during their ordinary laboratory work. The old method of free-hand sectioning rendered it an extremely difficult task even for an expert to make satisfactory sections of the delicate prothalline tissue. The profuse illustrations in this book, representing, as they do, the entire range of development, the chief features of anatomy and a comprehensive treatment of the structure of the sporangia of the different orders, are evidence of the comparative ease with which students may now, by this method, overcome obstacles which heretofore have stood in the way. From the intermediate position which ferns occupy in the plant kingdom their life-history presents a generalized view of the chief phenomena of plant life, and they are therefore admirably suited for studies of the biological aspect of botany, and form a suitable introduction to this phase of botanical instruction. The book is suited to assist students in laboratory classes in successfully tracing out the more difficult phases in the development of fern organs. The descriptive part affords a convenient means of reference at any step of the work, while the practical part deals with methods, preparation of material and instructions for prosecuting the various phases of the investigation, and is to be used as a laboratory guide. By its use, as first tested by the author in his own classes, the students are enabled to make with precision and accuracy permanent microscopic preparations of all the stages of development. Especial success has been had in adapting the collodion method to the handling of the delicate prothalline tissue, sexual organs and embryo, it being better suited to such delicate tissue than the paraffin method, and the preparation of material can be carried through in less time and with far less trouble. Permanent microscopic sections thus made serve the purpose of study, for future reference, and, if desired, for class illustration. The descriptive part occupies such a prominent part of the book that it will commend itself also to those who do not contemplate the practical study, but desire, in compact form, a much fuller account of fern history than can be obtained in ordinary text-books.

—Charles Scribner's Sons will publish a sumptuous art-work, entitled "Rembrandt: his life, his work and his time," by Emile Michel. Among their other books, nearly ready, are a new book by Dr. Henry M. Field, entitled "The Barbary Coast," a description of a leisurely journey to many interesting points in Algiers, Tunis and Tripoli.

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EXCHANGES.

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I am desirous of obtaining the following back numbers of *The Auk*: One copy each of Oct., 1885; July, 1886; January, 1887; July, 1887; April and July, 1891; and two copies each of the following: January, 1886; Oct. 1886; Oct., 1887; July, 1888; January, 1889; January, 1890. My own contributions in them only are required; otherwise the copies need not be perfect. I have in exchange for them two vols. (zoology) Mex. Bound'y Surveys (col. plates) or complete set of English reprints of "Osteology of Arctic Water-Birds, etc.' (o parts, 24 lith. plates); or other rare scientific reprints of any subject required. Address Dr. Shufeldt, Takoma, D. C.

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